Copper article with protective coating.

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Abstract of **EP0670378**

The present invention concerns a method of protecting a copper article against corrosion. The article is immersed in an aqueous solution containing equal parts of sodium hydroxide and sodium chlorides to form a uniform black oxide coating covering the exposed surfaces of the article. Thereafter, the oxidized surfaces are electrocoated with an acrylic paint to provide a continuous protective barrier over the exposed surfaces. The method can, for example be used, for protecting copper heat exchanger against corrosive environments.

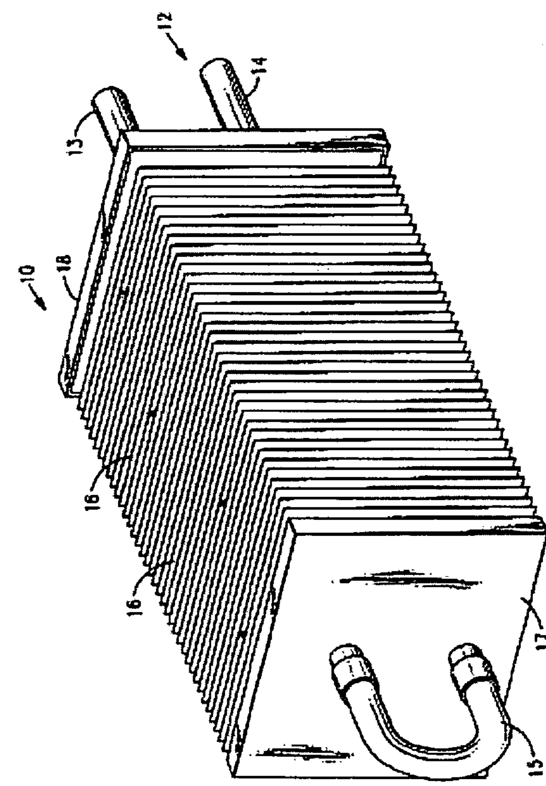

FIG.1

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(54) Copper article with protective coating.

(57) The present invention concerns a method of protecting a copper article against corrosion. The article is immersed in an aqueous solution containing equal parts of sodium hydroxide and sodium chlorides to form a uniform black oxide coating covering the exposed surfaces of the article. Thereafter, the oxidized surfaces are electrocoated with an acrylic paint to provide a continuous protective barrier over the exposed surfaces. The method can, for example be used, for protecting copper heat exchanger against corrosive environments.

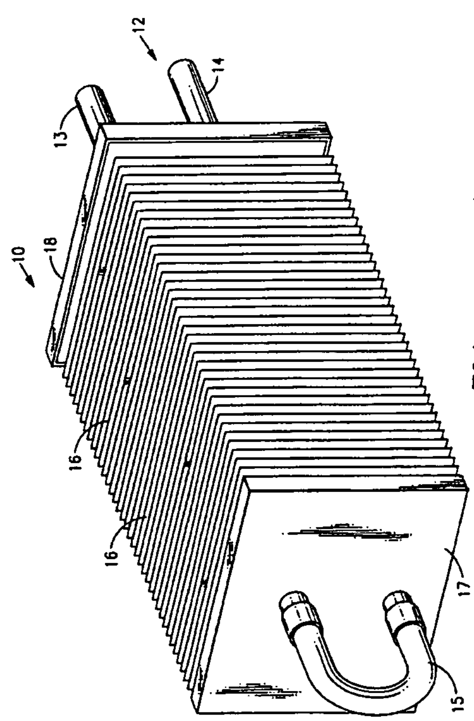

FIG.1

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It has been found that this combination exhibits unexpected synergistic results and does not degrade the heat transfer properties of the unit. Additionally, the protective barrier is capable of penetrating deeply into remote, difficult to access areas, thus preventing early failure.

Turning now to Fig. 2, there is shown a flow process diagram depicting the process steps involved in producing a uniform protective barrier over the entire outer surface of the copper heat exchanger. Initially, the two open ends of the flow circuit are closed by suitable plugs (not shown) and the exchanger is immersed in an alkaline bath 30 containing a strong base cleaner such as MI Clean 17 manufactured by Mitchell Bradford International, which is a division of Hubbard-Hall, Inc. of Waterbury, Connecticut. The bath contains a 4-7% concentration of MI Clean 17 in water and the solution is heated to a temperature of about 180°F. The heat exchanger is allowed to remain in the bath for about 5 to 10 minutes to thoroughly clean and degrease all exposed surfaces of the unit.

Upon removal from the alkaline bath, the unit is bathed in a cold water rinse 32 for about one minute or a period of time which is sufficient to remove the alkaline wash from the outer surface of the exchanger. The term cold water rinse as herein used refers to one in which the rinse water is at or about an ambient temperature.

The rinsed heat exchanger is then placed in a second acidic cleansing bath 34 for about 4 to 5 minutes to remove surface oxidations. The bath, held at an ambient temperature, contains about 10% concentration of Scone M-E Acid Brite 50 (also supplied by Hubbard-Hall, Inc.) in water. Acid Brite 50 contains about 20% by weight hydrochloric acid, 11% by weight phosphoric acid and 10% by weight sulfuric acid along with other nonacidic materials which combine to thoroughly ride the outer surfaces of the heat exchanger of unwanted oxides.

The unit, upon removal from the acid cleaning bath, is immediately placed in a cold water rinse 36 for about one minute or more to remove all trace of the acid bath from the outer surfaces of the unit.

The twice cleaned and rinsed part is now immersed in an oxidizing bath 38. The bath contains an oxidizing solution containing equal parts sodium hydroxide and sodium chloride in water. A concentration of about two pounds of oxidizer to a gallon of water is used. The oxidizer is commercially available from Hubbard-Hall, Inc. and is sold under the tradename Black Magic CB. The unit is allowed to remain in the bath for between 5 and 10 minutes at a bath temperature of about 180°F-210°F until all exposed surfaces of the copper are thoroughly coated with a deep black colored oxide film.

The oxidation process is quickly terminated by rinsing the unit in cold water for two to three minutes and then in hot water that is heated to about 120°F for about ten or eleven minutes. The unit is given a final rinse for about one to two minutes in deionized water at ambient temperature and allowed to dry. These rinses are depict at 40-42 in Fig. 2.

Upon drying, the unit is coated with an acrylic paint using commercially available coating equipment 44. The paint is available from Pittsburgh Plate Glass Industries, Inc. of Springdale Pennsylvania and is sold under the tradename Powercron 810-611 or Powercron 830-611. The oxidized unit is immersed in a bath of acrylic paint and an electrical current of ~234 amps and 200 volts applied to the unit. The unit is held in the bath for between nine and ten minutes to insure that all exposed and oxidized surfaces of the unit are fully covered with the acrylic overcoat to a thickness of between .0005 to .0010 inches. The unit is then removed from the bath and the paint cured in an oven 48 for thirty minutes at 375°F.

Copper parts that were oxidized and coated by the method described above were tested to determine the parts' ability to resist corrosion. The AC impedance of each coated part was first measured and recorded. The average impedance of the parts was found to be about 8×10^9 ohms per square centimeter and the average thickness of the acrylic coating was about 0.0007 inches. The parts were then exposed to steam spray for a period of about 48 hours and a second impedance measurement was then taken. The average impedance of the parts exposed to the steam was found to be about 7×10^8 ohms per square centimeter. Clearly these tests showed that the acrylic coating was relatively less porous than similar coating presently in use and thus provided an improved protective barrier against corrosion. Further tests also showed that the coating exhibited improved adhesive properties and resistivity to ultraviolet radiation when compared to presently employed coatings.

Although the present invention has been described with specific reference to a copper heat exchanger, it should be evident to one skilled in the art that the invention has wider applications and can be employed in conjunction with any type of copper article or part that may require extended protection from a hostile environment.

Claims

1. A method of protecting a copper article against corrosion that includes the steps of:

immersing the article in an aqueous solution containing about equal parts of sodium hydroxide and sodium chloride for a period of time sufficient to establish a uniform black oxide covering exposed surfaces of the article, and

electrocoating said oxidized surfaces with an acrylic paint to provide a continuous protective barrier over said exposed surfaces.

2. The method of claim 1 wherein the acrylic paint is electrocoated to a uniform thickness of about between .0005 and .0010 inches.

3. The method of claim 1 wherein said aqueous solution contains about two pounds of sodium hydroxide and sodium chloride in each gallon of water.

4. The method of claim 3 wherein said article is immersed in said aqueous solution for between 4 and 6 minutes.

5. The method of claim 1 that includes the further steps of precleaning and degreasing the exposed surfaces of the article prior to the oxidization step by immersing the article in an alkaline bath and then rinsing the article with water.

6. The method of claim 5 that further includes a second precleaning step of immersing the article after the first precleaning step in an acid bath to remove unwanted oxides from the exposed surfaces, and then washing the article with water.

7. The method of claim 6 that includes the further steps of rinsing the article after the oxidizing step in successive baths of cold water, hot water, and deionized water.

8. The method of claim 6 wherein said acid bath contains a 10% solution of sulfuric acid, phosphoric acid, and hydrochloric acid in water.

9. The method of claim 5 wherein said alkaline bath contains a 4% to 7% solution of sodium silicate in water.

10. The method of claim 1 wherein the electrocoating step lasts between nine and ten minutes so that the article has an AC impedance of between 10^8 and 10^9 ohms per cm^2.

11. The method of claim 1 that includes the further step of curing the acrylic paint coating in an oven at 350°F to 400°F for about thirty minutes.

2. The method of claim 1 wherein the acrylic paint is electrocoated to a uniform thickness of about between .0005 and .0010 inches.

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6. The method of claim 5 that further includes a second precleaning step of immersing the article after the first precleaning step in an acid bath to remove unwanted oxides from the exposed surfaces, and then washing the article with water.

7. The method of claim 6 that includes the further steps of rinsing the article after the oxidizing step in successive baths of cold water, hot water, and deionized water.

8. The method of claim 6 wherein said acid bath contains a 10% solution of sulfuric acid, phosphoric acid, and hydrochloric acid in water.

9. The method of claim 5 wherein said alkaline bath contains a 4% to 7% solution of sodium silicate in water.

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